Title of Investigation:

Education Outreach for Remote Sensing Operations at Wallops Flight Facility (WFF)

Principal Investigator:

Russell Dufrene (Code 598)

Other In-house Members of Team:

Jessica Thompson/598, Carl Snow/598

Other External Collaborators:

Dr. Douglas R. Levin (University of Maryland-Eastern Shore)

Initiation Year:

FY 2003

Aggregate Amount of Funding Authorized in FY 2003 and Earlier Years:

$25,000

FY 2004 Authorized Funding:

$8,000

Actual or Expected Expenditure of FY 2004 Funding:

In-house: $6,000; Grants: $2,000 (Marine Technology Club, Robinson High School, Tampa, Florida)

Status of Investigation at End of FY 2004:

To be continued in FY 2005 with funds remaining from FY 2004 and earlier years

Expected Completion Date:

August 2005

Purpose of Investigation:

The goal of this investigation is to develop the robotics infrastructure at the Wallops Flight Facility (WFF), the Pocomoke Discovery Center, and local universities and high schools. Another important goal is to make the robotics operate autonomously. This effort requires us to apply the latest concepts in artificial intelligence, human computer interaction, complex adaptive systems, and advanced sensor-networks technology.

This investigation, a collaboration between WFF and the University of Maryland-Eastern Shore (UMES), gives students the opportunity to build and experiment with robots and underwater scientific instruments. As part of this project, students build land- and water-borne robotic kits and

use remotely operated vehicles (ROVs) to collect and analyze geographically referenced data of all kinds. The program teaches high school students the scientific process by placing them in the role of a "scientist" as they prepare for technology competitions. NASA and the Goddard Space Flight Center (GSFC) benefit from this investigation because it inspires the next generation of explorers and it aligns scientific and educational outreach in both the NASA Earth Science and Education Enterprises..

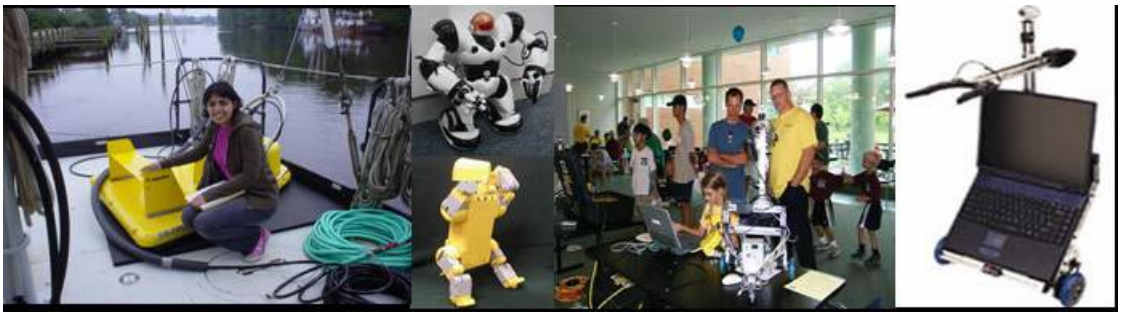
Accomplishments to Date:

In late 2003 and early 2004, two UMES undergraduate students, Tina Drew and John Wood, contributed immensely to the refurbishment and development of the Surface Operated Vehicle (SOV) and the Flexinol/Nitinol Stiquito "simple" robot experiment. While the SOV proved useful for the collection of data by students younger than high school age, the Stiquito robot was too complex for these younger students and will now be used for students in grades 9-12.

Figure 1: Surface Operated Vehicle (SOV) development and test

Incoming students for the summer of 2004 included Sahra Chaudary, who came from the GSFC Student Intern Program, and Jennifer Higgins, who came from the NASA Sharp Program. Sahra and Jenny modified the electronics board on a robotic dog, better known as "Old Yeller." Specifically, they added eyes that light up to give the robotic dog a more personal and friendly appearance. Sahra also learned how to use the Robosapian robot chosen for grades K-12 discovery education and completed an educational plan now under review. Jenny assisted Sahra in building the Evolutionary Robotics 1 (ER1) robot and making design recommendations for increased stability and safety.

Figure 2: Sarah on research vessel, Robosapien, Robot Dog, FUN Day, ER1 Robot



Dr. Levin attended the VideoRay ROV users conference on November 10-12, 2004 to negotiate a new partnership with the manufacturers of the VideoRay ROV. He also helped to install wireless ROV vehicle piloting software needed for educational purposes. This software installation program will allow students nationwide to remotely operate the VideoRay during several research missions through the use of the Internet. He also delivered the VideoRay ROV to Kristy Loman-Chiodo of Robinson High School, Tampa, Florida. Loman-Chiodo conducted a teacher workshop for eight

of her county science and math educators. In 2004, students and teachers in Florida operated the VideoRay ROV in the classroom and in an Olympic-size pool at a local recreational center. Dr. Levin and Loman-Chiodo attended a national education program for educators in California. Dr. Levin also was chosen to chair the 2006 Underwater ROV Competition in Washington D.C., in two years. Two middle school students built miniature remote-operating vehicles from PVC and motors from small personal fans. They designed, constructed, tested, and launched these small vehicles.

Two Pre-service Teacher Workshops are being presented at the NASA-sponsored 10th Annual Pre-Service Teacher Conference in Alexandria, Virginia, on February 17-19, 2005. They are entitled "Robotics in the Classroom," where up to 20 participants will learn to program Robosapien robots for educational curriculum, and "Building Underwater Robots."

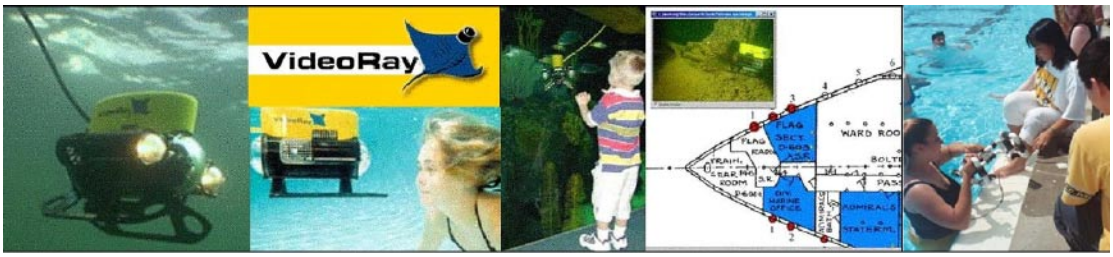


Figure 3: VideoRay ROV in use and with children

Publications and Conference Presentations:

This effort of research has produced one publication: Dufrene, W., R., Jr., 2004 "Application of artificial intelligence techniques in uninhabited aerial vehicle flight." IEEE Aerospace and Electronic Systems Magazine, August 2004,Vol 19, No. 8.

The investigations into artificial intelligence techniques has also led to two conference presentations:

- In 2003: "Application of Artificial Intelligence Techniques in Uninhabited Aerial Vehicle Flight," the 22nd Digital Avionics Systems Conference. • In 2004: "Approach for Autonomous Control of Unmanned Aerial Vehicle Using Intelligent Agents for Knowledge Creation," the 23rd Digital Avionics Systems Conference.

The principal investigator received a letter of appreciation for support of the Salisbury University "Fun Day." All the robots were available for "hands-on" discovery. More than 1,000 visitors participated in the robot discovery and education.

Planned Future Work:

Enough equipment and parts were purchased to allow the construction of six fully functioning underwater robots. Matching funds from other grants are being used to purchase tether cable, propellers, and other miscellaneous materials to complete the kits. These robots will be used as part of the teacher workshop. The participants will be given the opportunity to design and build the PVC frame and then attach pre-wired thrusters to them. Over the course of the workshop, they will test where best to place the thruster for optimum mobility, learn how to fly the ROVs in the local YMCA pool, and run them through an obstacle course to measure their "dexterity." We will explore how to get these lessons integrated into the local high school and middle school curriculum.

Summary:

This project attempts to use state-of-the-art robotics to educate students through hands-on programs involving local educators. The ROV is providing Dr. Levin with advanced technology for his scientific sounding operations and is helping to educate teachers. This project attempts to bring a high level of autonomy to the current state-of-the-art robots and can help advance the core expertise to WFF. Although we failed this year to make the robots operate autonomously, we succeeded in reaching out to teachers and students. If we can apply our knowledge in the area of complex adaptive systems, we believe NASA would benefit, especially in the area of robotic systems. The project's criterion for success is to eventually operate the ROV, ER1, or "Old Yeller" autonomously, using techniques from complex adaptive systems. This criterion has not been met.

We have not achieved autonomous operations for several reasons. The principal investigator has not been able to apply the theoretical research in autonomy and complex adaptive systems. The complexity of these applications needs further study and algorithm development and testing. These areas of development are new and risky. Attempts to acquire additional funding through other NASA programs have also failed. We have, however, achieved a higher level of exposure with the robotics, and support from local universities and educators. We believe that the risk will eventually pay off and efforts will continue, although on a much smaller scale, and much slower pace, through support from Code 598.